Assessing the yield response to deep ripping near Muradup, Western Australia. 2018 Update

Simon Zacher,'Parahills Farm', Muradup; **Emma Russell**, Southern DIRT; **Jeremy Lemon**, Department of Primary Industries and Regional Development; **Joel Andrew,** Map IQ.

Key messages

1. Deep ripping provided a 260kg/ha yield increase in barley in 2016,
2. Deeper ripping and the use of slotting plates did not improve canola yield in 2017,

Aims

To assess the impact of deep ripping on crop yield in a gravelly loam soil type near Muradup, WA.

Method

A replicated trial was established approximately 20kms north west of Kojonup by farmer Simon Zacher, Southern DIRT and DPIRD in 2016 to assess the effect of deep ripping.

Replicated plots ripped to 350mm and 550mm without slotting plates were setup along with additional cultivation treatments added to the edge of the trial Table 1).

In total 23 plots, 12m wide and 400m long, were established which aligned with existing controlled traffic lines. Six undisturbed 'Nil' plots were distributed across the trial though not in each replication.

Table 1: Ripping treatments and number of plots at the trial on Simon Zachers farm near Muradup, WA.

Treatment	No of plots
Nil	6
Ripper _550mm	3
Ripper_350mm	3
Ripper_350mm+Slotting	4
Helripper_600mm	3
Offset Disk_150mm	2
Scarifier_250mm	2

The trial was sown with the growers seeding machinery as part of the normal seeding operations each season. The paddock was sown to barley in 2016, canola in 2017 and wheat in 2018. Harvesting of the trial plots was carried out separate to the surrounding crop using the grower's harvester and recorded using a weight trailer. The yield data for the 2018 crop was unfortunately not available for analysis.

Soil and plant measurements

Soil penetration resistance using a digital cone penetrometer was measured twice in each plot in 2017. Where possible, the rip line was located and five insertions were recorded at each site with the average of these insertions used to characterise the soil resistance at each location. The gravel content at the site was thought to have made the digital cone penetrometer record incorrectly high values as the cone came up against gravel rocks. To overcome this, bulk density measurements were made using an in-situ three dimensional (3D) scanning technique developed by Scanlan *et al* (2018). This technique involves:

1. taking a 3D scan of a soil core,
2. calculating the volume of the core void,
3. measuring the weight of soil that was removed from the void and then,
4. calculating the soil bulk density.

Initially, a 10cm deep soil core was created using a posthole borer with all the soil removed from the layer kept to be dried and weighed. A 3D scanner (3D Systems, Sense 2 camera) was used to capture multiple images of the hole which the scanner software used to create a 3D model of the void (Figure 2).

Figure 1: Example of the 3D scanning equipment used to calculate bulk density (left) and shears for plant biomass cuts (right).

The process was then repeated for each 10cm layer to a depth of 40cm resulting in a void model for each layer (Figure 2). The model was then processed and analysed in the MeshLab 2016.12 software (Cignoni *et al*, 2008) to remove redundant points around the surface and holes that occurred in the model. MeshLab was then used to convert the void model into a water tight manifold from which volume was calculated (Figure 3).

The soil collected from each layer was dried and weighed in the laboratory to determine the mass contained in each void. Bulk density of each void layer in each plot was then calculated and reported in g/cm^3. Soil pH was also carried

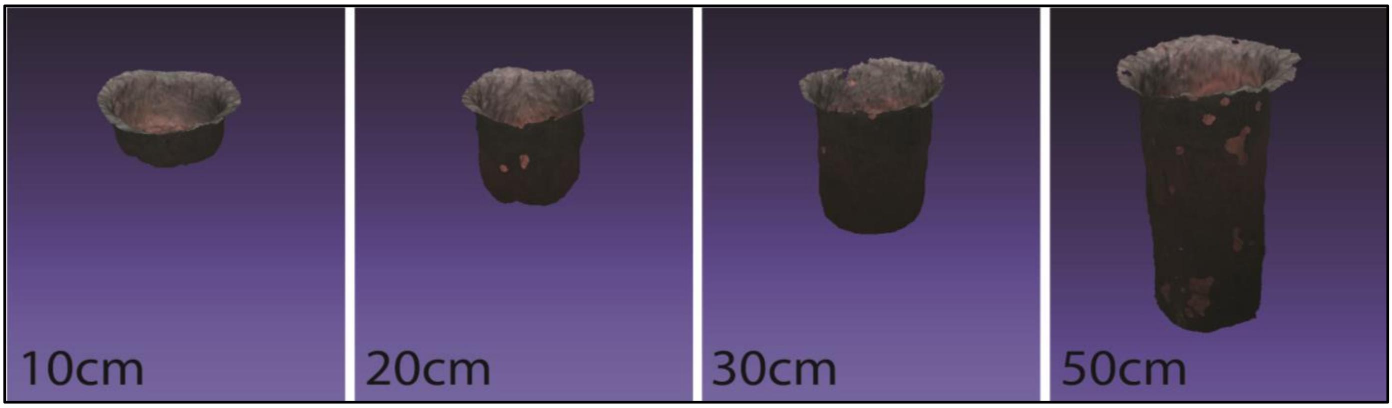

Figure 2: The raw 3D models of the voids captured in plot at the trial site. The soil for each 10cm layer was collected and the hole was 3D scanned to create a void model for each layer to a depth of 40cm.

out on the soil collected from the hole to measure soil acidity in each plot.

Plant biomass (g/m^2) was collected in each treatment by removing plant matter along three 0.5m row using shears (Figure 1). The location for the plant cuts was chosen at random though then the rip line was looked for at that location. The plant cuts were collected directly above the rip strip.

Normalised Difference Vegetation Index (NDVI) was collected using an Un-manned Aerial Vehicle (UAV) to assess differences in above ground plant biomass between plots (Figure 7).

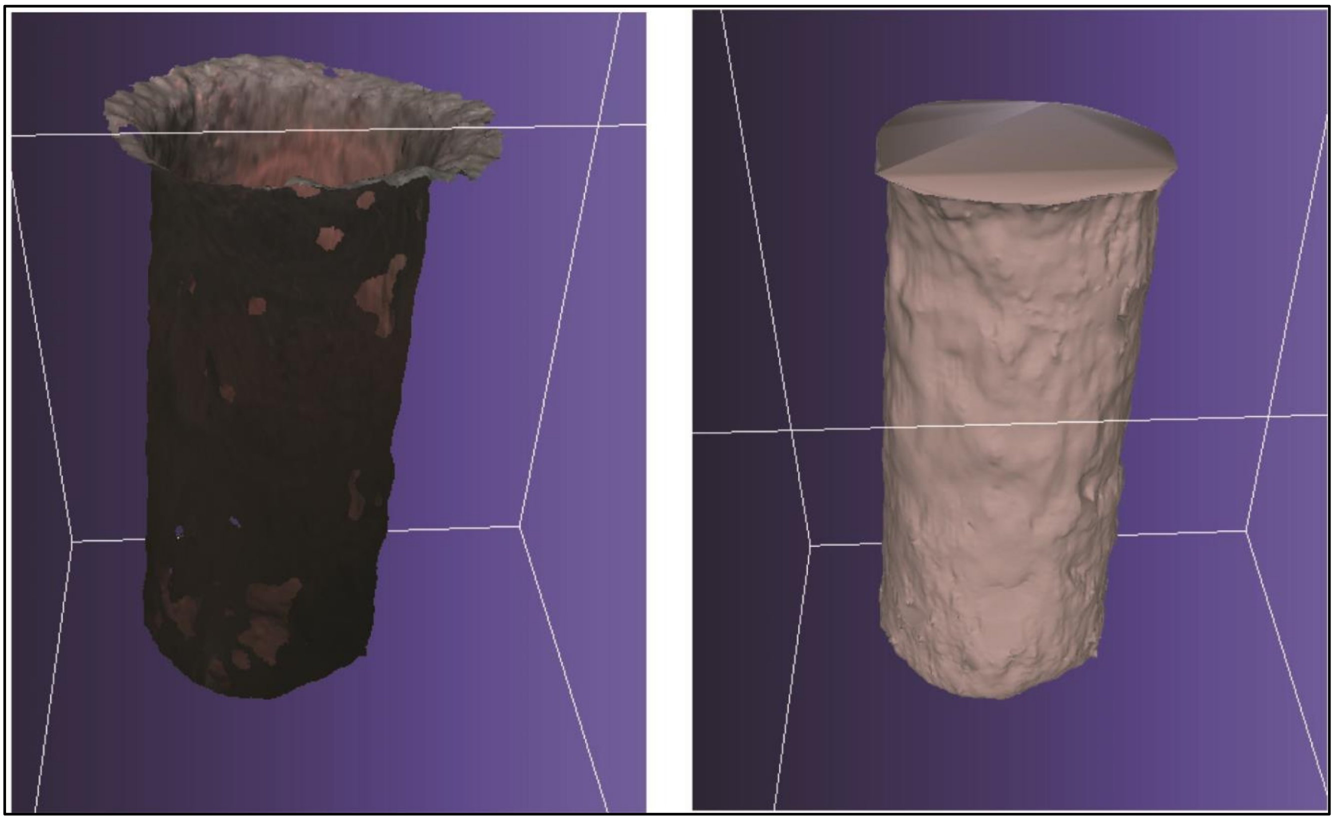

Figure 3: The raw void model (left) was processed in MeshLab to remove holes and then used to create a water tight manifold (right) from which volume was calculated.

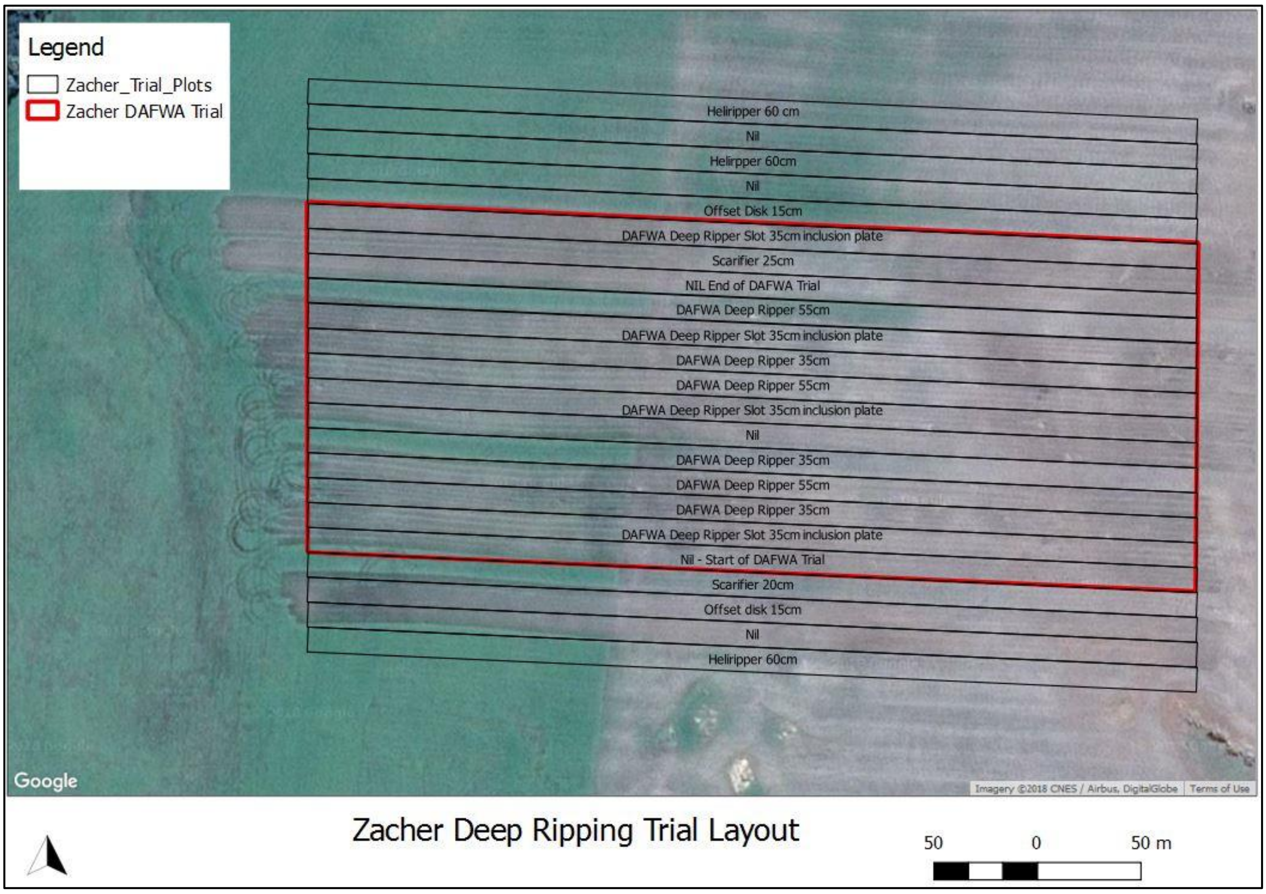

Figure 4: A replicated deep ripping trial (plots in red border) was established on the Zacher farm near Muradup in 2016. Additional cultivation treatments were added at the edge of the trial to compare the effect of scarifier, offset disc and Helripper on crop yield.

Results and Discussion

Crop Yield

Comparison of the annual yield response has been split into two groups to reflect the treatments that are replicated and those that are not for both the 2016 and 2017 seasons.

A significant yield difference was observed only in the 350mm rip treatment in 2016 which gave a 260kg/ha increase (lsd = 204kg/ha) over the Nil plots. There was a non-significant yield difference of approximately 200kg/ha for the other ripping treatments in 2016. The offset disc and scarifier treatments indicated a yield increase over the Nil plots and the Heliripper suggested a yield decrease, though the significance of these trends cannot be verified and are likely misleading.

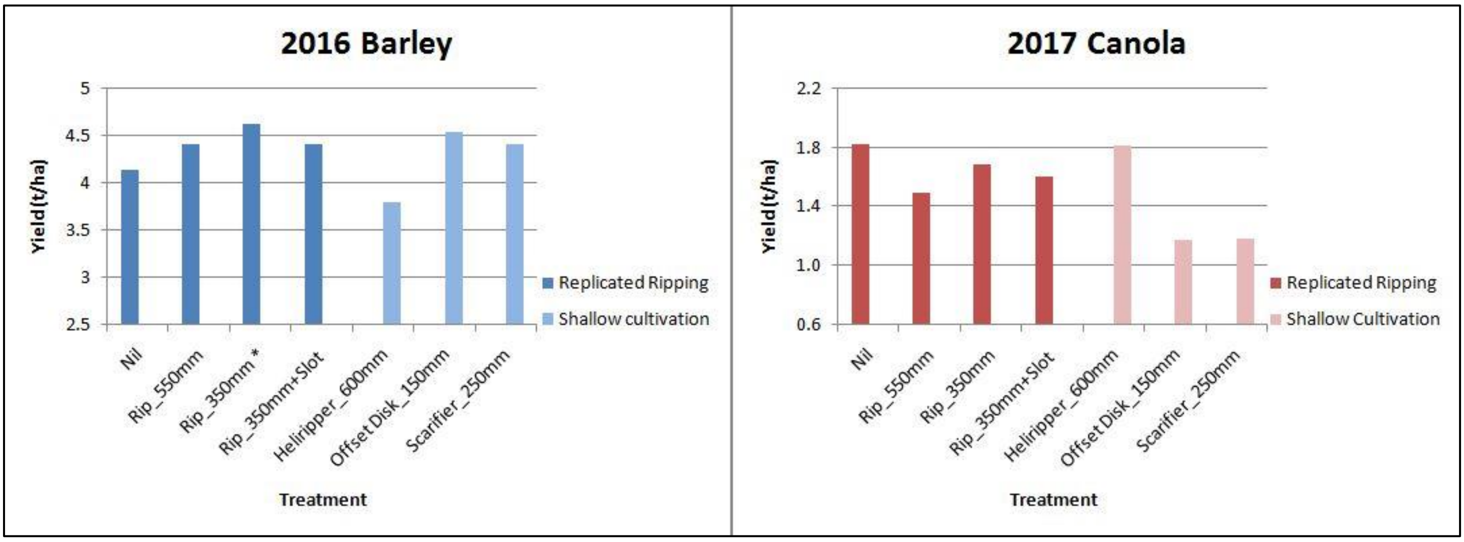

Figure 5: Average crop yield for the deep ripping and control plots showed that deep ripping to 350mm provided a yield benefit in 2016. Significance is represented by the * in the treatment label on the x axis

Yield data in 2017 showed an overall decrease in yield in all ripping treatments when compared to the Nil treatment except in the un-replicated Heliripper treatment which had a similar yield to the nil treatments.

Windy conditions prior to harvesting the trial resulted in pod shatter and an estimated 50% loss of grain. An un-even application of in season nitrogen was found using the UAV NDVI imagery (Figure 7) and unfortunately both of these issues raise concerns about the validity of the 2017 yield results.

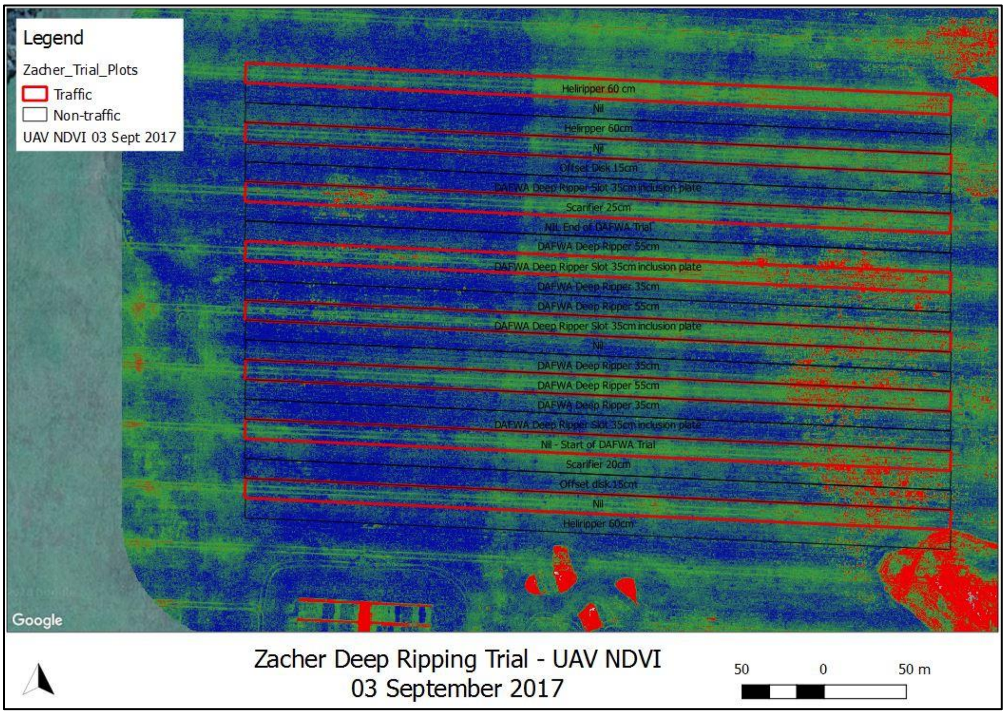

Figure 6: UAV NDVI imagery captured on 03 September 2017 shows variations in biomass across the trial. The influence of gravel soiltype on biomass can be seen on the eastern end and the influence of past merged paddock can be seen on the western end.

Soil and Plant Measurements

Soil coring across the trial site confirmed that loamy sand over gravelly clay and sandy gravel loam over gravel were the two soil types present (Figure 8). The sandy gravel was located in the eastern end of the trial and this area was excluded from all analysis.

A Rimick CP300 Cone Penetrometer was used to measure soil compaction at 46 locations across the trial. This was made up of five insertions at 2 locations along each plot. Insertions locations were randomly chosen in the control plots though the ripping line was found and measurements taken from within the rip line for the ripped plots.

No measurements were collected from the shallow cultivation treatments or below 600mm in the other treatments. Many locations had too much gravel to measure compaction accurately and were discarded from the data set.

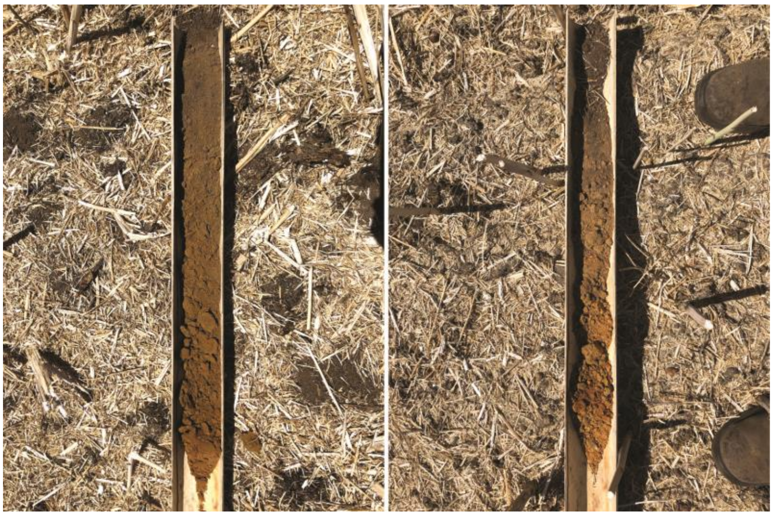

Figure 7: Soil types found at the site were either a loamy sandy over gravelly clay (left) or sandy gravel loam over gravel (right).

The average soil strength was found to be reduced in the deep ripping plots to the depth of working then increased (Figure 9). The control plots consistently reached 2500kpa between 150 – 200mm soil depth and increased to peak at 4500-5000kpa at 400mm depth. Deep ripping plots generally maintained compaction levels below 2500kpa to 400mm depth then increased to levels similar to the control plots.

Previous research has found 2500kpa to be the compaction level where plant root growth begins to be inhibited. This indicates that the deep ripping did not remove compaction as a constraint below 400mm across the trial site.

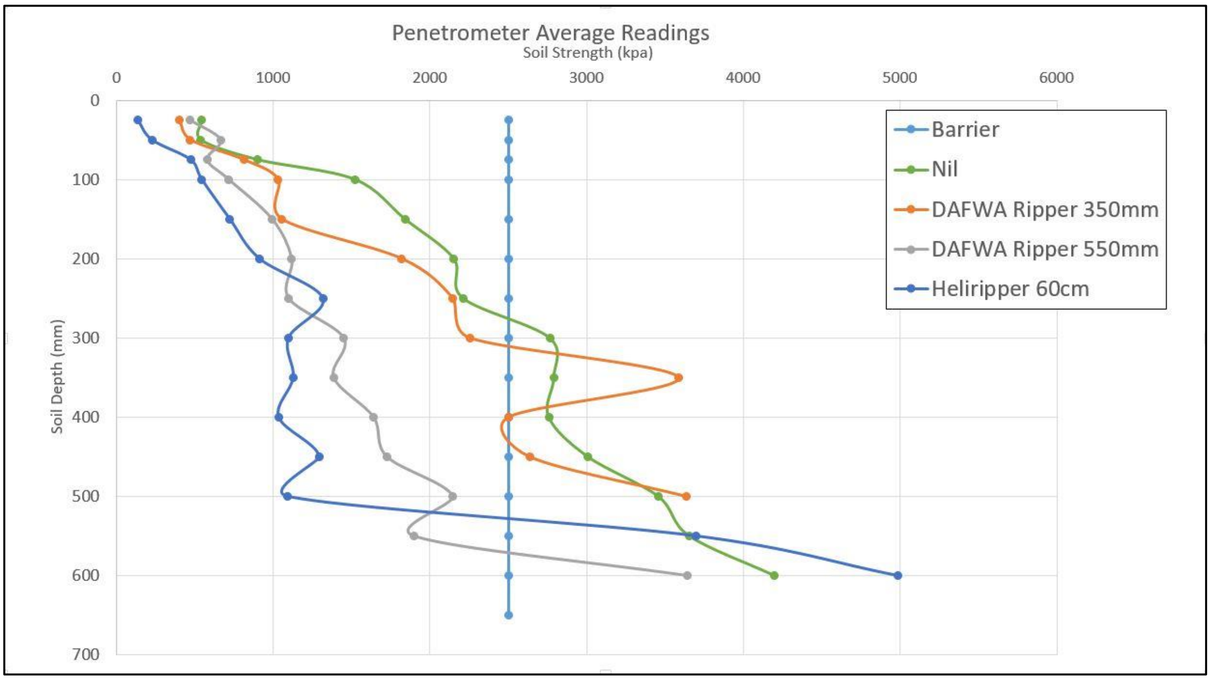

Figure 8: Average soil strength measurements from ripped and control plots as recorded by a cone penetrometer in August 2017.

The 3D scanning bulk density cores were collected 150 metre in from the eastern edge of DAFWA replicate two trial plots with the exception of one of the 350mm + Slotting plots which were not sampled. Soil type was a consistent loam sand over gravel sand over gravel.

Bulk density increased with depth in the control plots though the maximum values at 50cm are not thought to result in compaction being a major constraint. The bulk density of the ripped plots varied and showed an increase in bulk density with depth in the 350mm + slotting and 550mm ripping plots when compared to the adjacent control plots (Table 1).

Table 2: Bulk density of soil from each plot was calculated across the trial area.

Treatment	Dry Soil Weight (g)				Void Volume (cm^3)				Bulk Density			
	10cm	20cm	30cm	50cm	10cm	20cm	30cm	50cm	10cm	20cm	30cm	50cm
Control	5,500	10,587	15,574	21,074	4,258	7,489	10,365	15,078	1.29	1.41	1.50	1.40
DAFWA 350mm	6,589	9,986	15,426	22,015	4,436	7,368	11,235	14,535	1.49	1.36	1.37	1.51
DAFWA 350mm + Slotting	4,532	10,697	20,956	25,488	4,125	8,215	10,569	14,835	1.10	1.30	1.98	1.72
DAFWA 550mm	5,245	10,365	18,414	23,659	4,625	6,987	10,365	14,525	1.13	1.48	1.78	1.63

Though the bulk density values found at the site are not thought to be high enough to impede plant root growth, the measurements stop at 50cm. Penetrometer readings indicate compaction is likely to increase deeper than this level and may increase further than was able to be measured. Effort was made to find the middle of the rip lines for all cores so this may represent the loosest, least compact parts of the soil profile.

Plant biomass in 2018 showed no significant increase in biomass for the ripping treatments though did measure a significant reduction in biomass for the 350mm + Slotting plots (Figure 9). This is thought to be caused by two sampling sites having much lower plant counts were the samples were collected.

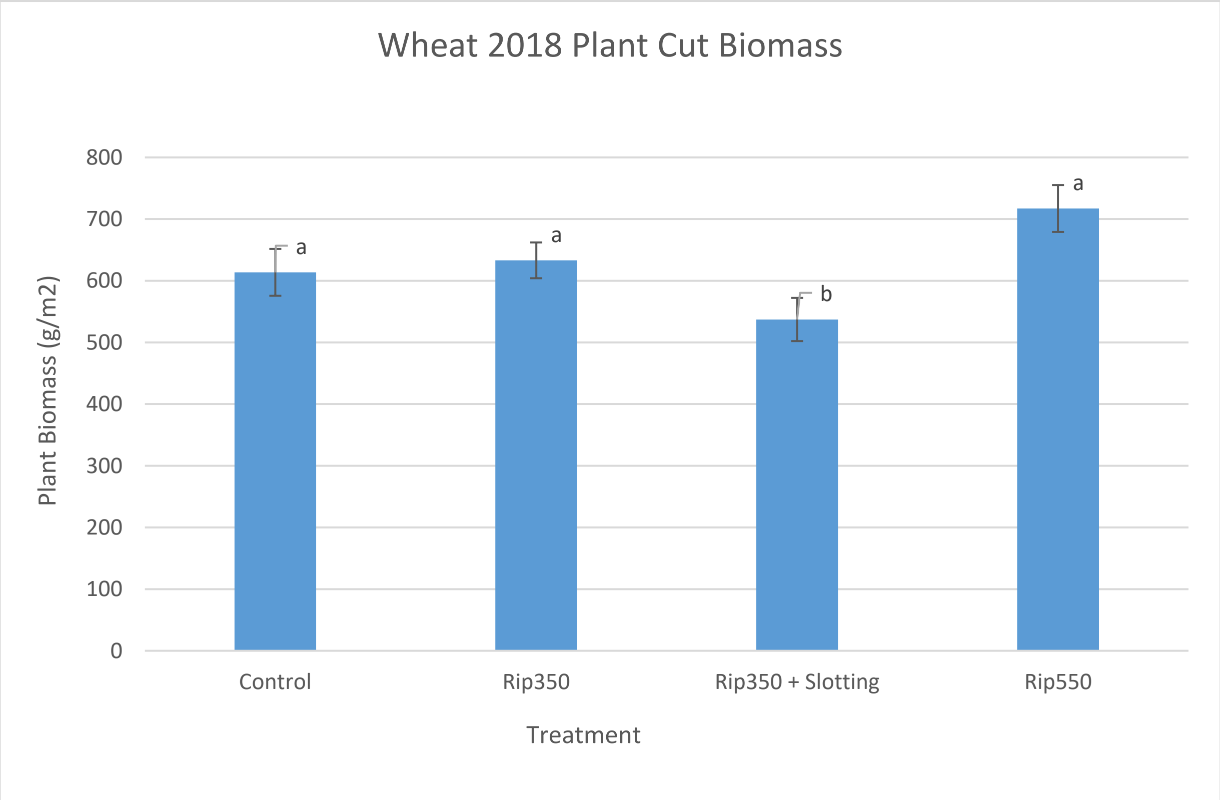

Figure 9: Plant biomass as measured by plant cuts from the 2018 wheat crop.

Returns of Deep Ripping

An economic analysis of the advantage of deep ripping at this site can only be carried out for the 2016 cropping season due to the 2017 yield being compromised and the 2018 data not being available.

All deep ripping treatments returned a positive yield and economic benefit, with the exception of the Heliripper 600mm treatment which ended giving $108/ha less than the control (Table 2). The ripping 350mm and 550mm provided similar benefits of $54/ha and 50/ha respectively. The ripping 350mm + Slotting treatment returned $108/ha and the indicating that the use of slotting plates doubled the effectiveness of the deep ripping at this depth.

Table 2: Economic return of the treatments for the 2016 season.

Treatment	Treat. Cost ($/ha)	Amortised Treat. Cost over three years ($/ha/yr)	Benefit from Ripping 2016 ($/ha) Barley @ $250/t	Accumulated Return - Costs over three years ($/ha)
Control	-	-	0	0
Rip 350mm	40	13	68	54
Rip 350mm + Slotting	45	15	123	108
Rip 550mm	55	18	68	50
Heliripper_600mm	70	23	-85	-108
Offset Disk_150mm	15	5	98	93
Scarifier_250mm	15	5	69	64

The yield responses from shallower ripping treatments provided an average economic increase of $79/ha suggesting that the yield response may be caused by something other than subsoil compaction.

The longevity of the treatment effect will determine how cost effective deep ripping is in this environment and on these soil types.

Conclusion

Ongoing yield increases, like the positive result from barley in 2016, are likely to have provided a positive return on investment to the farm business. The yield response from the 2018 crop and the upcoming 2019 season will give an indication of the longevity of the deep ripping effect and therefore how likely it is that an ongoing economic advantage will be realized from the practice.

Acknowledgments

The research undertaken as part of this project is made possible by the significant contributions of the Zacher family who setup the demonstration sites in conjunction with Southern Dirt and Jeremy Lemon from DPIRD. This assessment of the trial and report is an investment by the GRDC

GRDC Project Number: AVP00003-A